FUNCTIONALIZED NANO-MICROSTRUCTURES TO COMBAT BIOFOULING OF INDUSTRIAL SURFACES

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Biofilm formation is a strategy that bacteria use in order to survive in hostile environments, causing serious problems in the food industry, cooling water systems, medical equipment, etc. [1]. The control and destruction of undesirable biofilms often includes the use of chemical products with antimicrobial properties like biocides and surfactants. However, these substances can be considered harmful for the environment and consequently should be used in as small quantities as possible.

The goal of the work is to develop a novel procedure for biofilm control based on the transport of antimicrobial compounds on nano-microparticles or capsules. In this study, the efficacy of the method against suspended cells of *Pseudomonas fluorescens* was assessed, using benzyldimethyldodecylammonium chloride (BDMDAC), which is a surfactant belonging to the family of benzalkonium chloride, as a biocide carried on microparticles (diameter: 4 μm). The latter were prepared using the layer-by-layer self-assembly (LBL) technique [2]. The oppositely charged polyethyleneimine (PEI), sodium polystyrene sulfonate (PSS) and BDMDAC were assembled on polystyrene (PS) cores (Figure 1).

The BDMDAC coated particles were observed by CryoSEM and their composition by X-ray microanalysis (Figure 2). Their size distribution (Coulter Particle Size Analyzer) and zeta potential (Nano Zetameter) were also determined. The evaluation of the minimum amount of surfactant/biocide needed for effective microbial reduction was carried out through the determination of the survival ratio of the microbial population after different periods of exposure to BDMDAC coated particles (Figure 3). The assays were performed with a cell suspension in sterile saline solution (0.85% NaCl) containing $1.1\times10^{3}\pm150$ UFC/ml. After exposure to BDMDAC coated particles, the enumeration of viable cells was done spreading on Plate Count Agar, and incubation for 24h at 30ºC. A cell suspension without contact with the biocide was used as control. The possibility of reusing the BDMDAC coated microparticles to increase their life time and save biocide was also studied in order to optimize the industrial cleaning procedures (Figure 4).

References:

[1] Melo, L.F., Vieira, M.J., Bioprocess Engineering, **Physical stability and biological activity of biofilms under turbulent flow and low substrate concentration (**1999) 20, 363-368

[2] Cordeiro, A. L., Coelho, M., Sukhorukov, B. G., Dubreuil, F., Möhwald, H., Journal of Colloids and Interface Science, **Effect of shear stress on adhering polyelectrolyte capsules**, (2004) 280, 68-72

Figures:

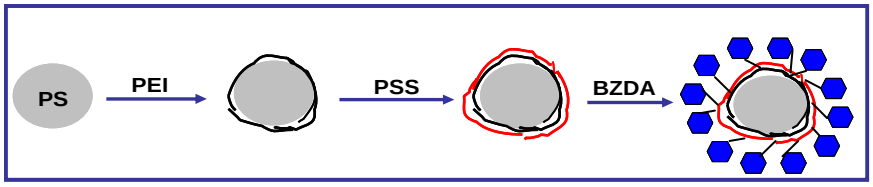

Figure 1: Schematic sequence of the formation process of the microparticles.

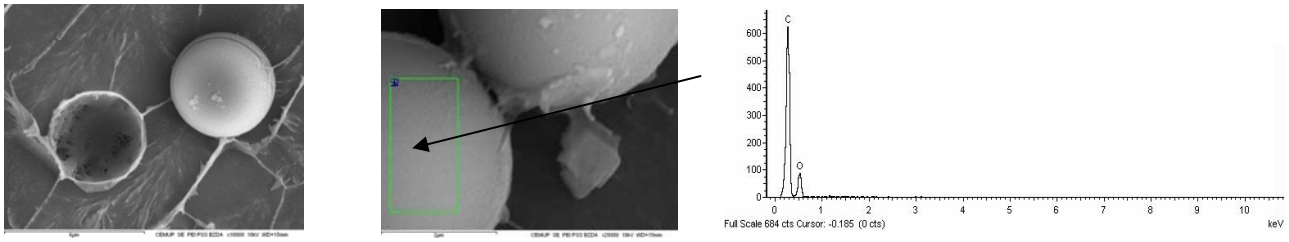

Figure 2: CryoSEM image of the coated particles and X-ray Microanalysis of the coating layer.

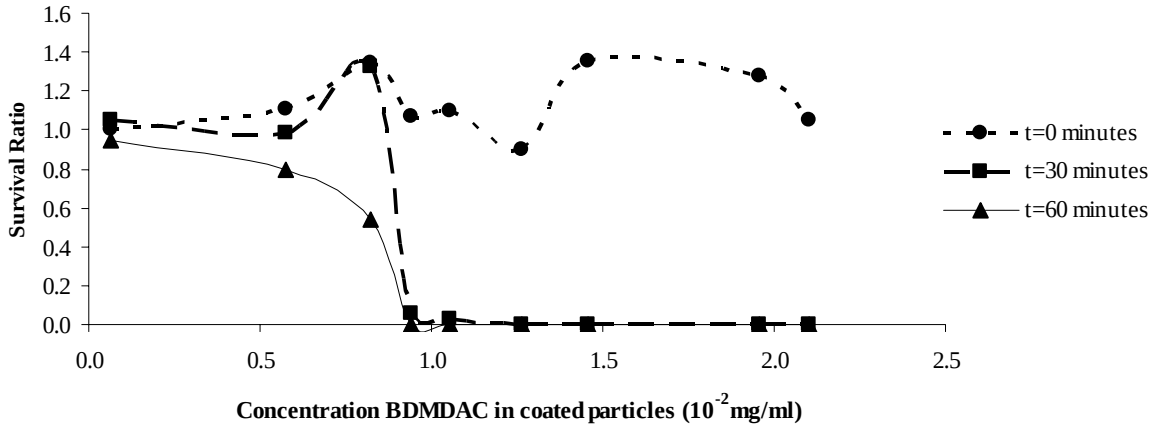

Figure 3: Determination of the minimum concentration of adsorbed biocide needed for effective biocidal action.

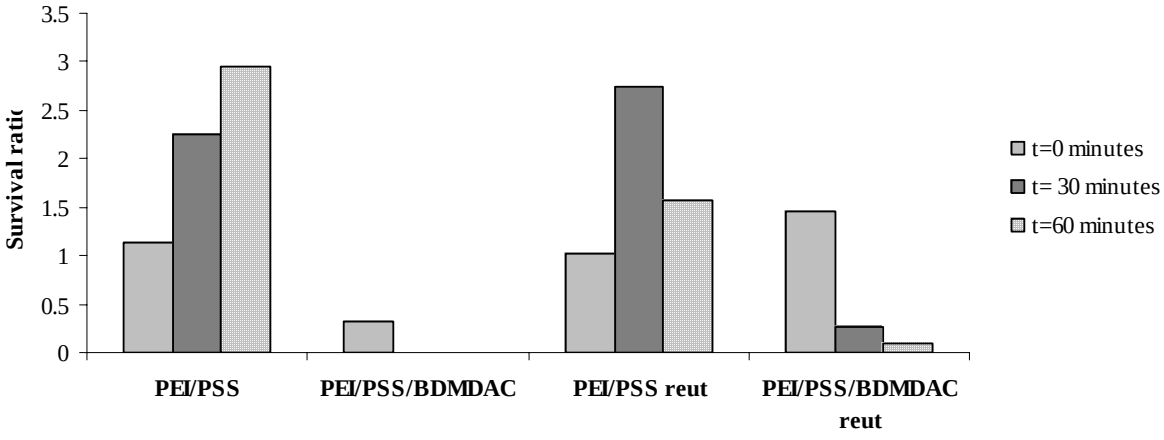

Figure 4: Reutilization test for the biocide coated particles at the minimum biocide concentration. Microparticles without biocide (PEI/PSS) were used as control.